CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, California 91125-8300

Caz Scislowicz
Director, Environment, Health, & Safety
1200 E. California Blvd., MC 25-6
Pasadena, CA 91125

December 21, 2011

Jeff Wong, PhD
Chief Scientist
Department of Toxic Substances Control
1001 "I" Street
P.O. Box 806
Sacramento, CA 95812-0806

Re: Formal request for chemical information and analytical test methods for specified nanomaterials: nanometals, nanometal oxides, and quantum dots.

Dear Dr. Wong,

In response to the January 04, 2010 call-in request by the Department of Toxic Substance Control (DTSC), California Institute of Technology (Caltech) respectfully submits the following information regarding the specified material: nano silver, nano zero valent iron, and quantum dots. Nano cerium oxide and nano titanium dioxide are not used in Caltech's research activities.

Caltech is an independent privately supported institute dedicated to academic research. It is home to hundreds of researchers and numerous laboratories. As a result, the work performed at the institute is constantly evolving to accommodate the needs of the researchers. Nanomaterials are used for research and development purposes only and not for any commercial application.

Metal nanomaterial at Caltech:

Currently, about six research groups on campus use laboratory scale quantities of metal nanomaterial, estimated to be about 10 gram per year for the Caltech campus. This material is utilized in various types of basic research, including electronic and energy storage devices, biological imaging, and fundamental material science research.

The sources of metal nanomaterials on campus come from outside vendors such as BB International, TedPella and Nanopartz.

hazardous waste in tightly sealed containers, and disposes of the waste in a permitted waste treatment facility.

Caltech's Chemical Hygiene Plan http://www.safety.caltech.edu/documents/28-chemical_hygiene_plan.pdf provides environmental, health and safety guidance to researchers working in Caltech's laboratories with hazardous material. Caltech Environment, Health, & Safety staff meets with researchers working with nanomaterial to provide consultation and direction on minimizing occupational exposures and avoiding releases to the environment. A separate guide and Standard Operating Procedure template for the use of engineered nanomaterial http://safety.caltech.edu/services/Nanomaterials is available. This helps reinforce engineering and administrative controls, guides researchers on best work practices, and gives direction on storage and waste management techniques.

Referenced publications, included with this memo, provide information on some of the current applications of the specified nanoparticles as well as analytical test methods.

Please direct any inquires regarding this response or future information call-in and rule making to Caz Scislowicz, Director, Environment, Health, and Safety, caz@caltech.edu (626-395-6727).

Sincerely,

Caz Scislowicz
Director, Environment, Health, & Safety

cc: Jean-Lou A. Chameau, President, Caltech

Morteza Gharib, Vice Provost, Caltech

Attachments:

Attachments 1,2,3, and 4 are sampling of Caltech faculty research articles involving nano silver, nano zero valent iron, and quantum dots:

1. Rieger, S., Kulkarni, R. P., Darcy, D., Fraser, S. E. and Köster, R. W. (2005), "Quantum dots are powerful multipurpose vital labeling agents in zebrafish embryos," *Developmental Dynamics, 234: 670–681. doi: 10.1002/dvdy.20524*

2. Tan, H. J. and Dodd, J. L. and Fultz, B. (2009) "Thermodynamic and Kinetic Stability of the Solid Solution Phase in Nanocrystalline Li_(x)FePO_4," *Journal of Physical Chemistry C, 113 (48). pp. 20527-20530. ISSN 1932-7447*

3. Ryan J. Kershner, Luisa D. Bozano, Christine M. Micheel, Albert M. Hung, Ann R. Fornof,

Attachment 1

Quantum Dots Are Powerful Multipurpose Vital Labeling Agents in Zebrafish Embryos

Sandra Rieger,[1] Rajan P. Kulkarni,[2] Dan Darcy,[2†] Scott E. Fraser,[2] and Reinhard W. Köster[1*]

Recently, inorganic fluorescent contrast agents composed of semiconductor materials have been introduced to biological imaging approaches. These so-called quantum dots provide unique and promising properties unreached by organic fluorophores, but their use as contrast agents within live organisms has been limited, probably due in part to concerns about their in vivo tolerance. Using transparent zebrafish embryos, we challenged quantum dots with a series of intravital imaging problems. We show that quantum dots provide a high fluorescent yield within targeted tissues, possess immense photostability, can be targeted to specific subcellular compartments, remain within targeted cells as lineage tracers, are easily separable from conventional organic fluorescent dyes, and are fixable, allowing them to be used in combination with immunohistochemistry after live recordings. Thus, quantum dots combine the specific advantages of different organic fluorescent contrast agents and promise to become the first fluorophore feasible for long-lasting intravital time-lapse studies. Finally, we show by colabeling blood vessels of the vasculature and major axon tracts of the nervous system that, for establishing these networks, the same guidance cues might be used in some body parts, whereas in others, both networks appear to develop independently from one another. Thus, the bright fluorescence of quantum dots will help to unravel many open questions in the fields of embryology, cell biology, as well as phenotyping and disease diagnosis. *Developmental Dynamics 234:670 –681, 2005.* **© 2005 Wiley-Liss, Inc.**

Key words: zebrafish; bio-imaging; quantum dots; microangiography; contrast agent; lineage tracer

Received 9 February 2005; Revised 22 April 2005; Accepted 16 June 2005

Attachment 2

Thermodynamic and Kinetic Stability of the Solid Solution Phase in Nanocrystalline Li_xFePO_4

H. J. Tan,* J. L. Dodd,† and B. Fultz

Keck Laboratory, California Institute of Technology, Pasadena, California 91125

Received: July 27, 2009; Revised Manuscript Received: October 27, 2009

Samples of nanostructured Li_xFePO_4 with characteristic crystal sizes of 26 nm, and compositions of $x \gtrsim 0.35$ and 0.65, were synthesized by ball-milling and chemical delithiation. X-ray powder diffraction showed that the solid solution phase started to form whenever two-phase materials were heated above 200 °C. The solid solution phase of nanocrystalline $Li_{0.65}FePO_4$ was quick to form above 200 °C but did not unmix at lower temperatures. Unmixing below 200 °C was found after long-time annealing of nanocrystalline $Li_{0.35}FePO_4$, however, consistent with the equilibrium phase diagram of bulk Li_xFePO_4. The stability of the solid solution of nanocrystalline Li_xFePO_4 is kinetic in origin, perhaps originating with effects of crystal surfaces.

Attachment 3

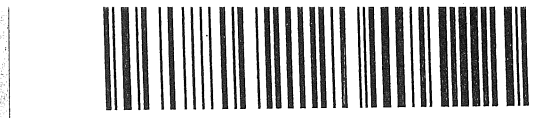
nature nanotechnology

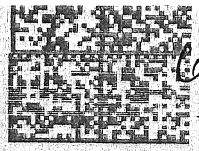
LETTERS

Placement and orientation of individual DNA shapes on lithographically patterned surfaces Ryan

J. Kershner[1†], Luisa D. Bozano[1], Christine M. Micheel[1†], Albert M. Hung[1†], Ann R. Fornof[1†], Jennifer N. Cha[1†], Charles T. Rettner[1], Marco Bersani[1†], Jane Frommer[1], Paul W. K. Rothemund[2*] and Gregory M. Wallraff[1*]

Artificial DNA nanostructures[1,2] show promise for the organization of functional materials[3,4] to create nanoelectronic[5] or nano-optical devices. DNA origami, in which a long single strand of DNA is folded into a shape using shorter 'staple strands'[6], can display 6-nm-resolution patterns of binding sites, in principle allowing complex arrangements of carbon nanotubes, silicon nanowires, or quantum dots. However, DNA origami are synthesized in solution and uncontrolled deposition results in random arrangements; this makes it difficult to measure the properties of attached nanodevices or to integrate them with conventionally fabricated microcircuitry. Here we describe the use of electron-beam lithography and dry oxidative etching to create DNA origami-shaped binding sites on technologically useful materials, such as SiO_2 and diamond-like carbon. In buffer with ◆100 mM $MgCl_2$, DNA origami bind with high selectivity and good orientation: 70–95% of sites have individual origami aligned with an angular dispersion (+1 s.d.) as low as +10° (on diamond-like carbon) or +20° (on SiO_2).





RETURN RECEIPT REQUESTED

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